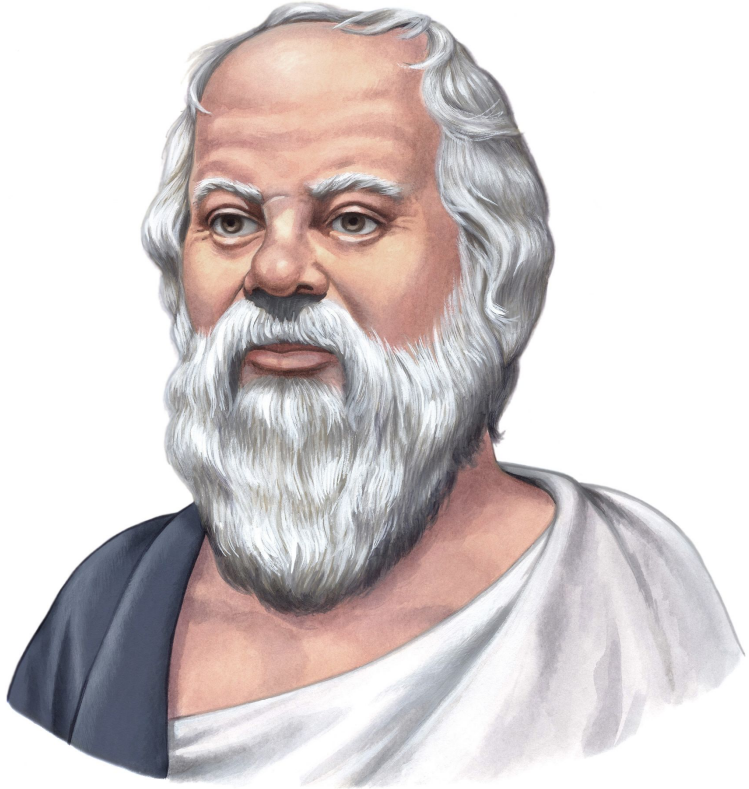
The only true wisdom is in knowing you know nothing.

- *Socrates*



Agenda for today

- Quick recap
- What is a sensor?
- Types of sensors with examples
  - Analog sensors
  - Digital sensors with binary output
  - Digital sensors with advanced features
- Hands-on
  - Interfacing an analog sensor
  - Interfacing a digital sensor with binary output
  - Interfacing a digital sensor with advanced features
- Daily challenge
- Prized challenges

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Sensors

Adding eyes and ears to devices

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What is a sensor?

- Device that converts a physical or chemical quantity into a corresponding Electrical quantity (voltage, current, pulses, etc)
- Human beings have 5 external sensor:Vision, touch, smell, taste, hearing
- Machines require sensors to comprehend their environment

Analog sensors

- Any physical quantity is analog by nature
- Give out a continuous voltage signal
- Require an ADC to convert output into digital signal, that can be used with processors and controllers

Examples of Analog sensors

- Temperature sensor (LM35): Gives voltage output corresponding the change in temperature
- Accelerometer(ADXL345): Gives voltage output corresponding the change in acceleration in different directions
- Sound sensor: Gives voltage output corresponding the change in sound intensity
- Light sensor
- Voltage sensor
- Current sensor
- Pressure sensor
- Force sensor
- Touch sensor
- Gas sensors: CO2, CO, CH3, LPG, Alcohol, etc.
- Hall-effect sensor: (Magnetic quantity)

Digital sensors: With binary output

- We can convert any analog sensor into a 2 level digital sensor using a comparator
- Examples:
  - Sound sensor: Triggers an output when the sound level (in dB) crosses a set limit
  - IR proximity sensor: Triggers when something comes in front of it
  - Hall-effect switch: Triggers when a magnets comes near it
  - Reed switch: Triggers when a magnets comes near it
  - Touch sensor:
  - Motion sensor:

Digital sensors: Advanced features

- These are the sensors which have features like:
  - Inbuilt signal processing
  - Temperature compensation
  - Serial communication port for 2-way communication
- Examples:
  - Temperature sensor: DS18b20
  - Accelerometer and gyroscope: MPU6050
  - Thermal imaging sensor: MLx90640
  - Multichannel gas sensor

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Hands-on

Get your hands dirty

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Interfacing Analog Sensor

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Connect a potentiometer with ESP8266

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Import Required Modules

Import required modules

```
from machine import Pin, ADC
from time import sleep
```

Attach ADC to a Pin

```
pot = ADC(Pin(6))

pot.atten(ADC.ATTN_11DB)
```

Add attenuation to change the voltage output range

Read pot reading and print on terminal

```
while True:
  pot_value = pot.read()
  print(pot_value)
  sleep(0.1)
```

Try replacing Potentiometer with temperature sensor

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Interfacing Digital Sensor with Binary output

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Connecting a push button to control on-board LED

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Import necessary modules

```
from machine import Pin
```

Define pins for LED and Push Button

```
led = Pin(2, Pin.OUT)     # 2 number in is Output
push_button = Pin(4, Pin.IN)   # 4 number pin is input
```

Turn on LED on Push Button Press

```
while True:
    logic_state = push_button.value()
    if logic_state == True:
        led.value(1)
    else:
        led.value(0)
```

Try replacing Push Button with a motion sensor

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Interfacing Advanced Digital Sensor

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Interfacing DS18B20 Temperature Sensor

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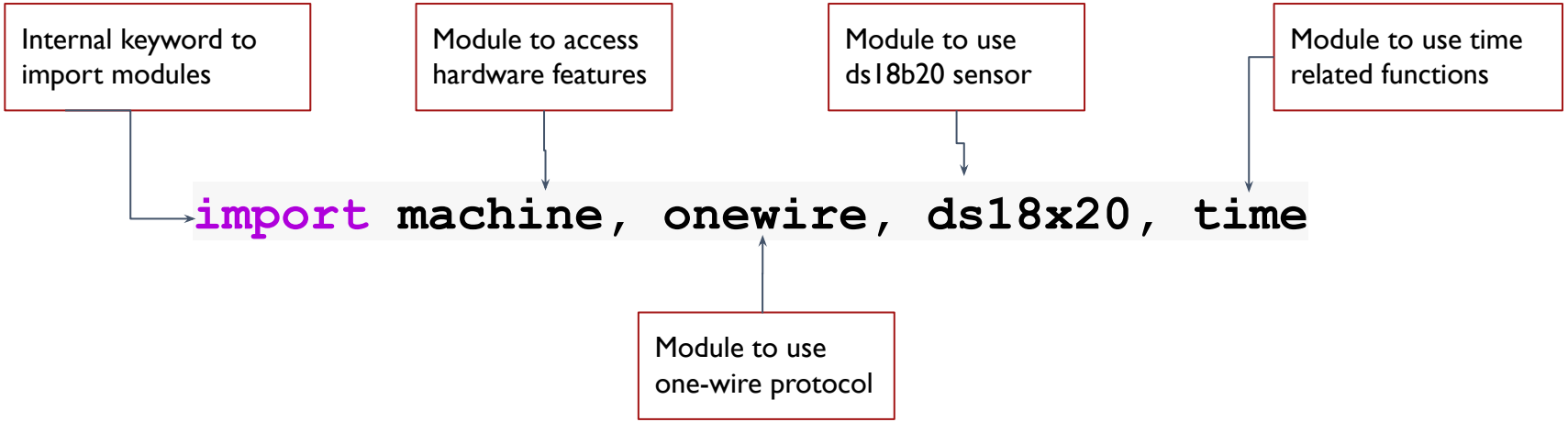
Import necessary modules (Libraries)



Define a pin to attach the sensor

```
ds_pin = machine.Pin(4)
```

Create an object of DS18x20 class


```
ds_sensor = ds18x20.DS18X20(onewire.OneWire(ds_pin))
```

Scan for devices

```
roms = ds_sensor.scan()
```

Scan for devices and store them in a variable

```
print('Found DS devices: ', roms)
```

Print the list of devices

Create a loop to get the temperature value

```
while True:
  ds_sensor.convert_temp()
  time.sleep_ms(750)
  for rom in roms:
    print(rom)
    print(ds_sensor.read_temp(rom))
  time.sleep(2)
```

DHT11 - Temp/Hum sensor

```
from machine import Pin
from time import sleep
import dht

sensor = dht.DHT22(Pin(14))
#sensor = dht.DHT11(Pin(14))
```

DHT11 - Temp/Hum sensor

```
while True:
  try:
    sleep(2)
    sensor.measure()
    temp = sensor.temperature()
    hum = sensor.humidity()
    temp_f = temp * (9/5) + 32.0
    print('Temperature: %3.1f C' %temp)
    print('Temperature: %3.1f F' %temp_f)
    print('Humidity: %3.1f %%' %hum)
  except OSError as e:
    print('Failed to read sensor.')
```

MPU6050 - Motion sensor

```
# Main code to read sensor data and display
from machine import I2C
from machine import Pin
from machine import sleep
import mpu6050
i2c = I2C(scl=Pin(22), sda=Pin(21))      #initializing the I2C method for ESP32
mpu= mpu6050.accel(i2c)
while True:
 mpu.get_values()
 print(mpu.get_values())
 sleep(500)
```

Daily Challenge

Problem Statement:

Use Wokwi to integrate DHT11 sensor with ESP8266 and print the Temperature and Humidity values on the terminal.

Hint:

- Sample code for integration is already available in the documentation

Prized Challenge 2

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Problem Statement:

Build a network of 3 devices with following features:

1. Every device has a sensor and an actuator (sensor and actuator can be simulated)
2. There is a common dashboard where we can see the sensor reading from the devices. Also, there should be buttons on dashboard to control actuators on each device.

Constraints:

- Overall system should be wireless
- Dashboard can be on any platform of your choice. However, I recommend Node-RED.

Resources required:

- 3 WiFi enabled Development boards
- A WiFi router/access point to connect the devices

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Thank you

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